Salt Marsh Monitoring in Lake Clark and Katmai National Parks and Preserves

By Torre Jorgenson, Gerald Frost, and Amy Miller

The coastal ecosystems of Lake Clark (LACL) and Katmai (KATM) National Parks and Preserves are among the most rare in the world owing to a combination of rapid tectonic uplift, high input of glacial sediments, frequent disturbance by volcanic eruptions, abundant spawning grounds for wild salmon, and a dense population of brown bears. Accordingly, salt marshes have been identified by the Southwest Alaska Network (SWAN) as a vital sign for assessing ecosystem health in the parks.

Salt marsh monitoring in SWAN focuses on major habitat characteristics and drivers of change that affect nearshore and terrestrial food webs and associated indicators (e.g., brown bears, seabirds, intertidal marine invertebrates, and algae). Drivers of change include geomorphic processes, changing topography and surface hydrology, tidal fluctuations and storm surges, sedimentation and erosion, salinity, and physical disturbance.

A sampling approach that incorporates intensive and extensive ground measurements and remote sensing techniques is being used for monitoring. Monitoring sites at Silver Salmon Creek and Chinitna Bay (LACL), and Hallo Bay (KATM) (*Figure 1*) consist of four transects perpendicular to the coastal gradient, with 4 x 10 m monitoring plots located at least every 330 ft (100 m) along the transects (*Figure 2*). Species cover, sediment accumulation, soil pH, and salinity are measured at each plot. Topographic surveys are completed across each transect, and one submersible pressure transducer (water level) and two soil temperature loggers are installed at each site. The monitoring effort requires a team of six people to sample three sites over a three-week period. Vegetation and soil sampling, and topographic surveys, will be repeated every ten years.

Sampling conducted in 2007-2008 provided baseline data on site conditions. Surface elevations vary less than 1.6 ft (0.5 m) across the inactive tidal flats, excluding the tidal channels, and 10-13 ft (3-4 m) across the barrier dunes. Large differences in mean water depths and soil salinity are evident among plant communities along the topographic gradient. High water levels typically reach ~8.2 ft (~2.5 m) above mean sea level, and no major storms have been recorded during the ice-free season.

A total of 127 taxa and 19 plant communities (*Figures 3-4*) were recorded in vegetation plots. A number of species provide forage for brown bears, including lupine (*Lupinus nootkatensis*), seaside arrowgrass (*Triglochin maritima*), goose tongue (*Plantago maritima*), Lygbye's sedge (*Carex lyngbyei*), and Ramensk's sedge (*Carex ramenskii*).

Landscape change was analyzed using a time-series of IKONOS satellite images (2005) and historical airphotos (1950s, 1980s) georectified to a common base (*Figure 5*). Waterbody mapping showed sediment deposition along the shoreline and migration of the shoreline seaward, with tidal guts decreasing 0.9% and tidal rivers increasing 0.6% in area. Shoreline accretion rates were similar at Hallo Bay (7.5 ft/2.3 m per year) and Silver Salmon Creek (5.2 ft/1.6 m per year) over the roughly 50-year interval, but lower at Chinitna Bay (1.6 ft/0.5 m per year). Increases in Sitka-Lutz spruce (2.0 ± 1.6%) and decreases in wet saline meadows dominated by *Carex ramenskii* (-1.2 ± 1.0%) were among the other changes recorded through photo interpretation.

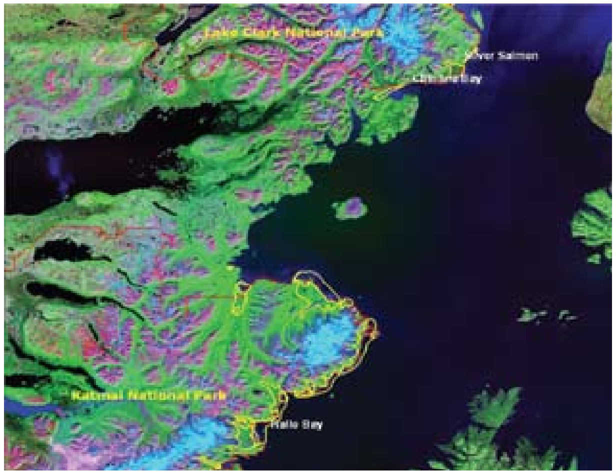
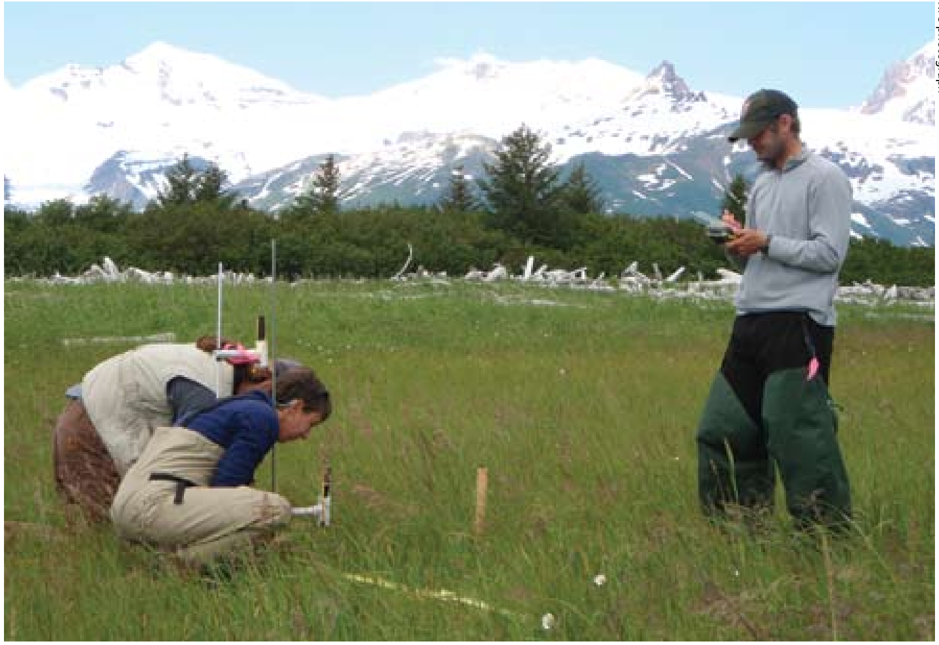


Figure 1. Locations of salt marsh study sites at Silver Salmon, Chinitna Bay, and Hallo Bay.



NPS photograph

Figure 2. Measurement of species cover in a *Carex ramenskii* meadow using point-intercept methods.

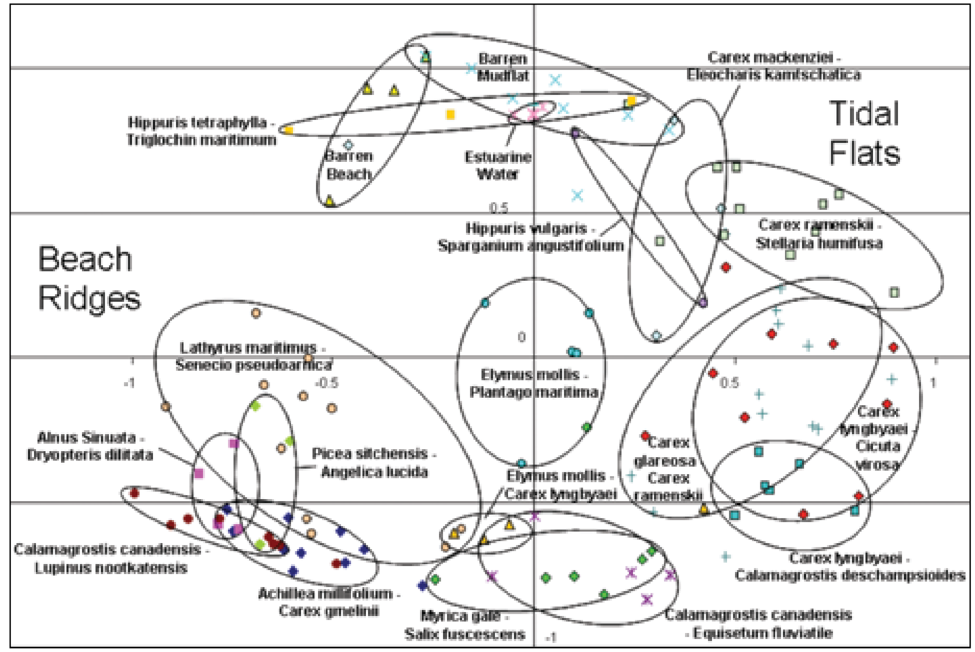


Figure 3. Floristic analysis of the vegetation data revealed 19 plant communities that inhabit the range of environmental conditions associated with varying soil texture, salinity, and water level. The communities are named by their dominant species and an indicator species that differentiates them from similar communities.

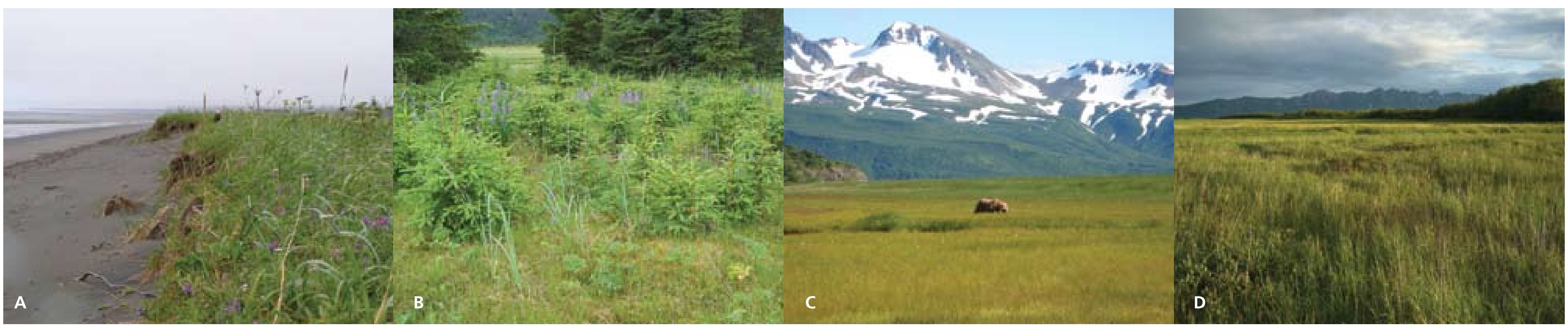


Figure 4. Example of common plant communities associated with salt marshes, including dunegrass-beach pea meadow (A); Sitka-Lutz spruce encroachment into a dunegrass-umbel meadow (B); *Carex ramenskii* meadow, a source of high quality forage for bears (C); and sweetgale shrubland at the upper, inland margins of inactive tidal flats (D).

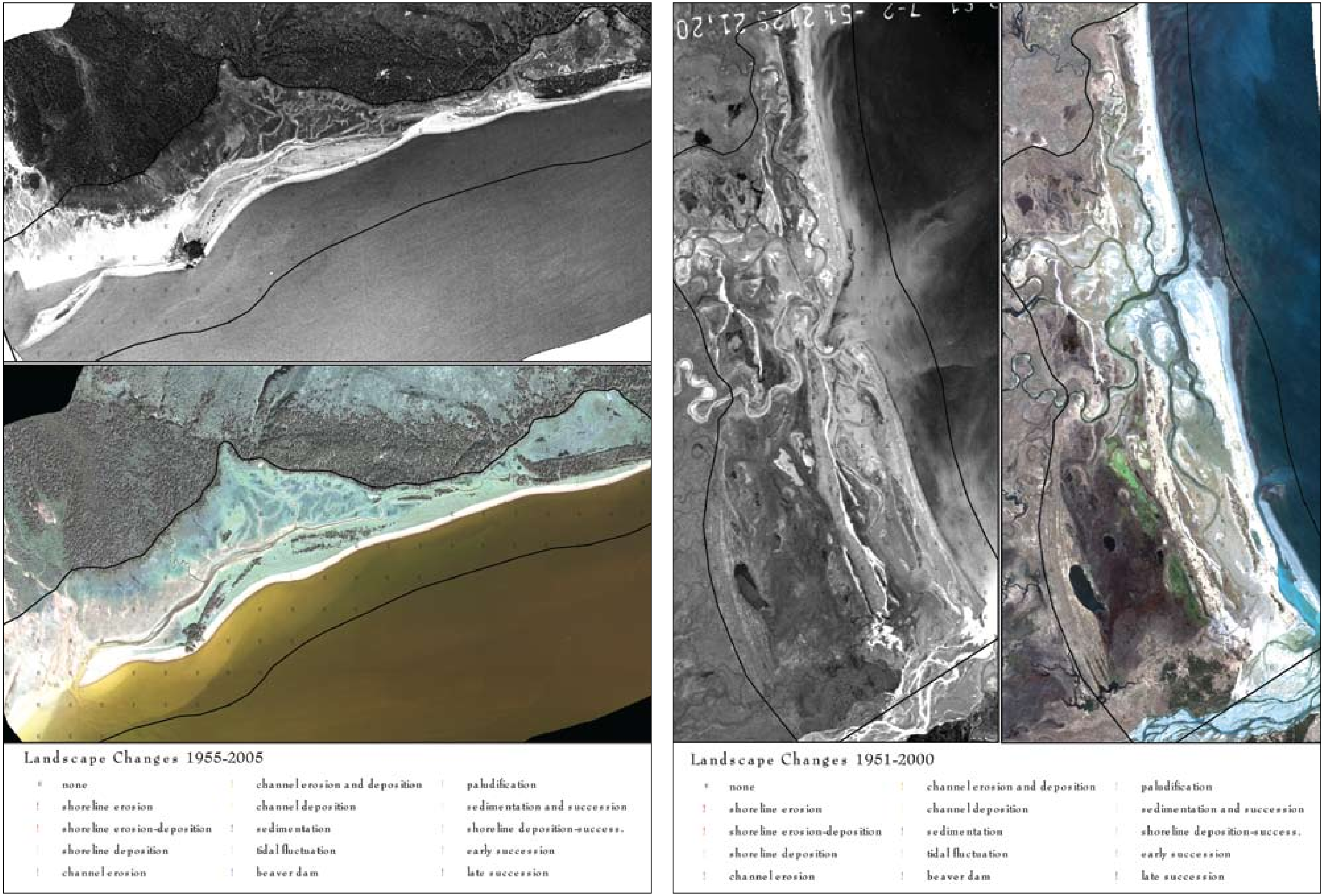


Figure 5. Examples of shoreline change that have occurred over the last 50 years (1951-2005) in salt marshes of the SWAN. Changes were photo-interpreted at 650 ft (200 m) spacing denoted by the small cross-hairs; points where change was evident are color coded. Most of the change is associated with shoreline erosion and deposition (left), tidal channel migration, and plant succession on beach ridges, including spruce establishment (right).